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# BRAKE TESTING

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## BRAKE TEST OBJECTIVE

Determine the deceleration rate attained by each test vehicle on twelve 60 – 0 mph impending skid (threshold) stops, with ABS in operation if the vehicle is so equipped. Each vehicle is scored on the average deceleration rate it attains.

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## BRAKE TEST METHODOLOGY

Each vehicle makes two decelerations at specific predetermined points on the test road from 90 – 0 mph at 22 ft/s<sup>2</sup>, with the driver using a decelerometer to maintain the deceleration rate. Immediately after these “heat-up” stops are completed, the vehicle is turned around and makes six measured 60 – 0 mph impending skid (threshold) stops with ABS in operation, if so equipped, at specific predetermined points. Following a four (4) minute heat soak, the entire sequence is repeated. The exact initial velocity at the beginning of each of the 60 – 0 mph decelerations, and the exact distance required to make each stop is recorded by means of a non contact optical sensor in conjunction with electronic speed and distance meters. The data resulting from the twelve total stops is used to calculate the average deceleration rate which is the vehicle’s score for this test.

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## DECELERATION RATE FORMULA

$$\text{Deceleration Rate (DR)} = \frac{\text{Initial Velocity}^2 (\text{IV})^2}{2 \text{ times Stopping Distance (SD)}} = \frac{(\text{IV})^2}{2 (\text{SD})}$$

### EXAMPLE:

$$\begin{aligned} \text{Initial Velocity} &= 89.175 \text{ ft/s (60.8 mph x 1.4667*)} \\ \text{Stopping Distance} &= 171.4 \text{ ft.} \end{aligned}$$

$$\text{DR} = \frac{(\text{IV})^2}{2(\text{SD})} = \frac{(89.175)^2}{2(171.4)} = \frac{7952.24}{342.8} = 23.198 \text{ ft/s}^2$$

Once a vehicle’s average deceleration rate has been determined, it is possible to calculate the stopping distance from any given speed by utilizing the following formula:

Select a speed; translate that speed into feet per second; square the feet per second figure by multiplying it by itself; divide the resultant figure by 2; divide the remaining figure by the average deceleration rate of the vehicle in question.

### EXAMPLE:

$$60 \text{ mph} = 88.002 \text{ ft/s} \times 88.002 = 7744.352 / 2 = 3872.176 / 23.198 \text{ ft/s}^2 = 166.9 \text{ ft.}$$

\*Initial velocity must be expressed in terms of feet per second, with 1 mile per hour being equal to 1.4667 feet per second.

## BRAKE TESTING

TEST LOCATION: Chrysler Proving Grounds

DATE: September 15, 2007

BEGINNING Time: 9:05 a.m.

TEMPERATURE: 45.7°F

MAKE & MODEL: Ford Police Interceptor 4.6L 3.27

BRAKE SYSTEM: Anti-lock

### Phase I

BRAKE HEAT-UP: (Two 90 → 0 mph decelerations @ 22 ft./sec.<sup>2</sup>)

TEST: (Six 60 → mph impending skid (ABS) maximum deceleration rate stops)

	Initial Velocity	Stopping Distance	Deceleration Rate
Stop #1	60.5 mph	146.9 feet	26.78 ft/s <sup>2</sup>
Stop #2	59.7 mph	142.5 feet	26.85 ft/s <sup>2</sup>
Stop #3	60.3 mph	147.3 feet	26.58 ft/s <sup>2</sup>
Stop #4	60.7 mph	143.5 feet	27.62 ft/s <sup>2</sup>
Stop #5	60.4 mph	145.3 feet	27.04 ft/s <sup>2</sup>
Stop #6	60.8 mph	150.2 feet	26.46 ft/s <sup>2</sup>

**AVERAGE DECELERATION RATE**

**26.89 ft/s<sup>2</sup>**

HEAT SOAK (4 minutes)

### Phase II

BRAKE HEAT-UP: (Two 90 → 0 mph decelerations @ 22 ft./sec.<sup>2</sup>)

TEST: (Six 60 → mph impending skid (ABS) maximum deceleration rate stops)

	Initial Velocity	Stopping Distance	Deceleration Rate
Stop #1	60.2 mph	146.1 feet	26.71 ft/s <sup>2</sup>
Stop #2	60.3 mph	143.4 feet	27.30 ft/s <sup>2</sup>
Stop #3	60.0 mph	144.2 feet	26.82 ft/s <sup>2</sup>
Stop #4	60.5 mph	147.6 feet	26.68 ft/s <sup>2</sup>
Stop #5	60.5 mph	147.2 feet	26.72 ft/s <sup>2</sup>
Stop #6	60.6 mph	140.8 feet	28.02 ft/s <sup>2</sup>

**AVERAGE DECELERATION RATE**

**27.04 ft/s<sup>2</sup>**

### Phase III

	Yes/No
Evidence of severe fading?	<u>No</u>
Vehicle stopped in straight line?	<u>Yes</u>
Vehicle stopped within correct lane?	<u>Yes</u>

**OVERALL AVERAGE DECEL. RATE:**

**26.97 ft/s<sup>2</sup>**

Projected Stopping Distance from 60.0 mph      143.6

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## BRAKE TESTING

TEST LOCATION: Chrysler Proving Grounds

DATE: September 15, 2007

BEGINNING Time: 11:10 a.m.

TEMPERATURE: 51.7°F

MAKE & MODEL: Ford Police Interceptor 4.6L 3.55

BRAKE SYSTEM: Anti-lock

### Phase I

BRAKE HEAT-UP: (Two 90 → 0 mph decelerations @ 22 ft.sec.<sup>2</sup>)

TEST: (Six 60 → mph impending skid (ABS) maximum deceleration rate stops)

	Initial Velocity	Stopping Distance	Deceleration Rate
Stop #1	60.3 mph	148.0 feet	26.40 ft/s <sup>2</sup>
Stop #2	60.5 mph	150.1 feet	26.20 ft/s <sup>2</sup>
Stop #3	60.1 mph	147.6 feet	26.31 ft/s <sup>2</sup>
Stop #4	59.5 mph	143.4 feet	26.58 ft/s <sup>2</sup>
Stop #5	59.7 mph	145.7 feet	26.27 ft/s <sup>2</sup>
Stop #6	61.0 mph	152.4 feet	26.27 ft/s <sup>2</sup>

**AVERAGE DECELERATION RATE**

**26.34 ft/s<sup>2</sup>**

HEAT SOAK (4 minutes)

### Phase II

BRAKE HEAT-UP: (Two 90 → 0 mph decelerations @ 22 ft.sec.<sup>2</sup>)

TEST: (Six 60 → mph impending skid (ABS) maximum deceleration rate stops)

	Initial Velocity	Stopping Distance	Deceleration Rate
Stop #1	61.2 mph	153.7 feet	26.24 ft/s <sup>2</sup>
Stop #2	59.7 mph	144.7 feet	26.46 ft/s <sup>2</sup>
Stop #3	60.0 mph	148.6 feet	26.03 ft/s <sup>2</sup>
Stop #4	60.5 mph	153.5 feet	25.63 ft/s <sup>2</sup>
Stop #5	60.3 mph	148.3 feet	26.40 ft/s <sup>2</sup>
Stop #6	60.3 mph	155.7 feet	25.08 ft/s <sup>2</sup>

**AVERAGE DECELERATION RATE**

**25.98 ft/s<sup>2</sup>**

### Phase III

	Yes/No
Evidence of severe fading?	<u>No</u>
Vehicle stopped in straight line?	<u>Yes</u>
Vehicle stopped within correct lane?	<u>Yes</u>

**OVERALL AVERAGE DECEL. RATE:**

**26.16 ft/s<sup>2</sup>**

Projected Stopping Distance from 60.0 mph 148.0

## BRAKE TESTING

TEST LOCATION: Chrysler Proving Grounds

DATE: September 15, 2007

BEGINNING Time: 12:20 p.m.

TEMPERATURE: 54.4°F

MAKE & MODEL: Chevrolet Impala 9C1 3.9L

BRAKE SYSTEM: Anti-lock

### Phase I

BRAKE HEAT-UP: (Two 90 → 0 mph decelerations @ 22 ft./sec.<sup>2</sup>)

TEST: (Six 60 → mph impending skid (ABS) maximum deceleration rate stops)

	Initial Velocity	Stopping Distance	Deceleration Rate
Stop #1	60.0 mph	142.2 feet	27.19 ft/s <sup>2</sup>
Stop #2	60.1 mph	141.2 feet	27.51 ft/s <sup>2</sup>
Stop #3	59.6 mph	141.4 feet	27.05 ft/s <sup>2</sup>
Stop #4	60.1 mph	144.2 feet	26.94 ft/s <sup>2</sup>
Stop #5	59.9 mph	142.9 feet	27.02 ft/s <sup>2</sup>
Stop #6	60.7 mph	147.7 feet	26.81 ft/s <sup>2</sup>

**AVERAGE DECELERATION RATE**

**27.09 ft/s<sup>2</sup>**

HEAT SOAK (4 minutes)

### Phase II

BRAKE HEAT-UP: (Two 90 → 0 mph decelerations @ 22 ft./sec.<sup>2</sup>)

TEST: (Six 60 → mph impending skid (ABS) maximum deceleration rate stops)

	Initial Velocity	Stopping Distance	Deceleration Rate
Stop #1	60.8 mph	147.4 feet	26.93 ft/s <sup>2</sup>
Stop #2	60.9 mph	150.0 feet	26.59 ft/s <sup>2</sup>
Stop #3	60.8 mph	143.8 feet	27.68 ft/s <sup>2</sup>
Stop #4	60.3 mph	143.3 feet	27.33 ft/s <sup>2</sup>
Stop #5	60.2 mph	142.0 feet	27.41 ft/s <sup>2</sup>
Stop #6	60.1 mph	149.7 feet	25.95 ft/s <sup>2</sup>

**AVERAGE DECELERATION RATE**

**26.98 ft/s<sup>2</sup>**

### Phase III

	Yes/No
Evidence of severe fading?	<u>No</u>
Vehicle stopped in straight line?	<u>Yes</u>
Vehicle stopped within correct lane?	<u>Yes</u>

**OVERALL AVERAGE DECEL. RATE:**

**27.03 ft/s<sup>2</sup>**

Projected Stopping Distance from 60.0 mph      143.2

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## BRAKE TESTING

TEST LOCATION: Chrysler Proving Grounds

DATE: September 15, 2007

BEGINNING Time: 1:05 p.m.

TEMPERATURE: 55.9°F

MAKE & MODEL: Dodge Charger 3.5L

BRAKE SYSTEM: Anti-lock

### Phase I

BRAKE HEAT-UP: (Two 90 →0 mph decelerations @ 22 ft.sec.<sup>2</sup>)

TEST: (Six 60 → mph impending skid (ABS) maximum deceleration rate stops)

	Initial Velocity	Stopping Distance	Deceleration Rate
Stop #1	60.5 mph	144.8 feet	27.15 ft/s <sup>2</sup>
Stop #2	62.1 mph	149.6 feet	27.71 ft/s <sup>2</sup>
Stop #3	60.0 mph	141.3 feet	27.37 ft/s <sup>2</sup>
Stop #4	60.4 mph	143.2 feet	27.44 ft/s <sup>2</sup>
Stop #5	60.7 mph	148.1 feet	26.78 ft/s <sup>2</sup>
Stop #6	59.8 mph	137.3 feet	28.03 ft/s <sup>2</sup>

**AVERAGE DECELERATION RATE**

**27.41ft/s<sup>2</sup>**

HEAT SOAK (4 minutes)

### Phase II

BRAKE HEAT-UP: (Two 90 →0 mph decelerations @ 22 ft.sec.<sup>2</sup>)

TEST: (Six 60 → mph impending skid (ABS) maximum deceleration rate stops)

	Initial Velocity	Stopping Distance	Deceleration Rate
Stop #1	60.0 mph	141.1 feet	27.45 ft/s <sup>2</sup>
Stop #2	60.3 mph	141.6 feet	27.61 ft/s <sup>2</sup>
Stop #3	61.1 mph	152.5 feet	26.30 ft/s <sup>2</sup>
Stop #4	60.7 mph	144.3 feet	27.48 ft/s <sup>2</sup>
Stop #5	59.6 mph	142.0 feet	26.91 ft/s <sup>2</sup>
Stop #6	60.7 mph	148.2 feet	26.76 ft/s <sup>2</sup>

**AVERAGE DECELERATION RATE**

**27.08 ft/s<sup>2</sup>**

### Phase III

Evidence of severe fading?

Yes/No

No

Vehicle stopped in straight line?

Yes

Vehicle stopped within correct lane?

Yes

**OVERALL AVERAGE DECEL. RATE:**

**27.25 ft/s<sup>2</sup>**

Projected Stopping Distance from 60.0 mph

142.1

## BRAKE TESTING

TEST LOCATION: Chrysler Proving Grounds

DATE: September 15, 2007

BEGINNING Time: 1:30 p.m.

TEMPERATURE: 55.8°F

MAKE & MODEL: Dodge Charger 5.7L

BRAKE SYSTEM: Anti-lock

### Phase I

BRAKE HEAT-UP: (Two 90 → 0 mph decelerations @ 22 ft./sec.<sup>2</sup>)

TEST: (Six 60 → mph impending skid (ABS) maximum deceleration rate stops)

	Initial Velocity	Stopping Distance	Deceleration Rate
Stop #1	60.6 mph	146.9 feet	26.93 ft/s <sup>2</sup>
Stop #2	60.7 mph	147.2 feet	26.90 ft/s <sup>2</sup>
Stop #3	60.4 mph	144.1 feet	27.21 ft/s <sup>2</sup>
Stop #4	60.2 mph	139.1 feet	28.05 ft/s <sup>2</sup>
Stop #5	60.4 mph	145.8 feet	26.87 ft/s <sup>2</sup>
Stop #6	60.2 mph	145.5 feet	26.77 ft/s <sup>2</sup>

**AVERAGE DECELERATION RATE**

**27.12 ft/s<sup>2</sup>**

HEAT SOAK (4 minutes)

### Phase II

BRAKE HEAT-UP: (Two 90 → 0 mph decelerations @ 22 ft./sec.<sup>2</sup>)

TEST: (Six 60 → mph impending skid (ABS) maximum deceleration rate stops)

	Initial Velocity	Stopping Distance	Deceleration Rate
Stop #1	60.2 mph	153.9 feet	25.36 ft/s <sup>2</sup>
Stop #2	60.6 mph	143.6 feet	27.55 ft/s <sup>2</sup>
Stop #3	60.4 mph	143.4 feet	27.34 ft/s <sup>2</sup>
Stop #4	60.1 mph	146.6 feet	26.51 ft/s <sup>2</sup>
Stop #5	60.0 mph	144.2 feet	26.86 ft/s <sup>2</sup>
Stop #6	60.6 mph	146.6 feet	26.97 ft/s <sup>2</sup>

**AVERAGE DECELERATION RATE**

**26.76 ft/s<sup>2</sup>**

### Phase III

	Yes/No
Evidence of severe fading?	<u>No</u>
Vehicle stopped in straight line?	<u>Yes</u>
Vehicle stopped within correct lane?	<u>Yes</u>

**OVERALL AVERAGE DECEL. RATE:**

**26.94 ft/s<sup>2</sup>**

Projected Stopping Distance from 60.0 mph      143.7

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## BRAKE TESTING

TEST LOCATION: Chrysler Proving Grounds

DATE: September 15, 2007

BEGINNING Time: 8:19 a.m.

TEMPERATURE: 42.2°F

MAKE & MODEL: Dodge Magnum 3.5L

BRAKE SYSTEM: Anti-lock

### Phase I

BRAKE HEAT-UP: (Two 90 → 0 mph decelerations @ 22 ft.sec.<sup>2</sup>)

TEST: (Six 60 → mph impending skid (ABS) maximum deceleration rate stops)

	Initial Velocity	Stopping Distance	Deceleration Rate
Stop #1	61.4 mph	141.5 feet	28.66 ft/s <sup>2</sup>
Stop #2	59.9 mph	138.8 feet	27.85 ft/s <sup>2</sup>
Stop #3	61.7 mph	144.3 feet	28.39 ft/s <sup>2</sup>
Stop #4	60.8 mph	136.7 feet	29.08 ft/s <sup>2</sup>
Stop #5	61.0 mph	138.2 feet	28.97 ft/s <sup>2</sup>
Stop #6	60.3 mph	135.7 feet	28.82 ft/s <sup>2</sup>

**AVERAGE DECELERATION RATE**

**28.63 ft/s<sup>2</sup>**

HEAT SOAK (4 minutes)

### Phase II

BRAKE HEAT-UP: (Two 90 → 0 mph decelerations @ 22 ft.sec.<sup>2</sup>)

TEST: (Six 60 → mph impending skid (ABS) maximum deceleration rate stops)

	Initial Velocity	Stopping Distance	Deceleration Rate
Stop #1	60.3 mph	135.9 feet	28.78 ft/s <sup>2</sup>
Stop #2	60.0 mph	138.1 feet	28.04 ft/s <sup>2</sup>
Stop #3	61.1 mph	145.7 feet	27.56 ft/s <sup>2</sup>
Stop #4	60.4 mph	138.3 feet	28.37 ft/s <sup>2</sup>
Stop #5	60.7 mph	140.0 feet	28.29 ft/s <sup>2</sup>
Stop #6	60.4 mph	135.7 feet	28.92 ft/s <sup>2</sup>

**AVERAGE DECELERATION RATE**

**28.33 ft/s<sup>2</sup>**

### Phase III

	Yes/No
Evidence of severe fading?	<u>No</u>
Vehicle stopped in straight line?	<u>Yes</u>
Vehicle stopped within correct lane?	<u>Yes</u>

**OVERALL AVERAGE DECEL. RATE:**

**28.48 ft/s<sup>2</sup>**

Projected Stopping Distance from 60.0 mph 136.0

## BRAKE TESTING

TEST LOCATION: Chrysler Proving Grounds

DATE: September 15, 2007

BEGINNING Time: 10:16a.m.

TEMPERATURE: 49.2°F

MAKE & MODEL: Dodge Magnum 5.7L

BRAKE SYSTEM: Anti-lock

### Phase I

BRAKE HEAT-UP: (Two 90 → 0 mph decelerations @ 22 ft./sec.<sup>2</sup>)

TEST: (Six 60 → mph impending skid (ABS) maximum deceleration rate stops)

	Initial Velocity	Stopping Distance	Deceleration Rate
Stop #1	60.4 mph	139.5 feet	28.16 ft/s <sup>2</sup>
Stop #2	59.9 mph	142.0 feet	27.15 ft/s <sup>2</sup>
Stop #3	61.4 mph	146.2 feet	27.76 ft/s <sup>2</sup>
Stop #4	60.7 mph	144.0 feet	27.56 ft/s <sup>2</sup>
Stop #5	60.6 mph	142.6 feet	27.67 ft/s <sup>2</sup>
Stop #6	60.3 mph	145.2 feet	26.92 ft/s <sup>2</sup>

**AVERAGE DECELERATION RATE**

**27.54 ft/s<sup>2</sup>**

HEAT SOAK (4 minutes)

### Phase II

BRAKE HEAT-UP: (Two 90 → 0 mph decelerations @ 22 ft./sec.<sup>2</sup>)

TEST: (Six 60 → mph impending skid (ABS) maximum deceleration rate stops)

	Initial Velocity	Stopping Distance	Deceleration Rate
Stop #1	60.4 mph	143.5 feet	27.34 ft/s <sup>2</sup>
Stop #2	59.9 mph	137.3 feet	28.10 ft/s <sup>2</sup>
Stop #3	60.7 mph	145.9 feet	27.18 ft/s <sup>2</sup>
Stop #4	60.7 mph	147.4 feet	26.90 ft/s <sup>2</sup>
Stop #5	60.4 mph	142.5 feet	27.56 ft/s <sup>2</sup>
Stop #6	60.4 mph	145.7 feet	26.95 ft/s <sup>2</sup>

**AVERAGE DECELERATION RATE**

**27.34 ft/s<sup>2</sup>**

### Phase III

	Yes/No
Evidence of severe fading?	<u>No</u>
Vehicle stopped in straight line?	<u>Yes</u>
Vehicle stopped within correct lane?	<u>Yes</u>

**OVERALL AVERAGE DECEL. RATE:**

**27.44 ft/s<sup>2</sup>**

Projected Stopping Distance from 60.0 mph      141.1



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## BRAKE TESTING

TEST LOCATION: Chrysler Proving Grounds

DATE: September 15, 2007

BEGINNING Time: 10:00 a.m.

TEMPERATURE: 48.8F

MAKE & MODEL: Chevrolet Tahoe 5.3L 2WD

BRAKE SYSTEM: Anti-lock

### Phase I

BRAKE HEAT-UP: (Two 90 →0 mph decelerations @ 22 ft.sec.<sup>2</sup>)

TEST: (Six 60 → mph impending skid (ABS) maximum deceleration rate stops)

	Initial Velocity	Stopping Distance	Deceleration Rate
Stop #1	60.0 mph	144.0 feet	26.92 ft/s <sup>2</sup>
Stop #2	60.6 mph	151.7 feet	26.05 ft/s <sup>2</sup>
Stop #3	59.9 mph	142.6 feet	27.10 ft/s <sup>2</sup>
Stop #4	60.1 mph	141.8 feet	27.44 ft/s <sup>2</sup>
Stop #5	60.2 mph	141.7 feet	27.55 ft/s <sup>2</sup>
Stop #6	60.7 mph	146.4 feet	27.05 ft/s <sup>2</sup>

**AVERAGE DECELERATION RATE**

**27.02 ft/s<sup>2</sup>**

HEAT SOAK (4 minutes)

### Phase II

BRAKE HEAT-UP: (Two 90 →0 mph decelerations @ 22 ft.sec.<sup>2</sup>)

TEST: (Six 60 → mph impending skid (ABS) maximum deceleration rate stops)

	Initial Velocity	Stopping Distance	Deceleration Rate
Stop #1	60.1 mph	143.1 feet	27.16 ft/s <sup>2</sup>
Stop #2	60.2 mph	147.3 feet	26.45 ft/s <sup>2</sup>
Stop #3	60.1 mph	145.2 feet	26.80 ft/s <sup>2</sup>
Stop #4	60.7 mph	147.1 feet	26.89 ft/s <sup>2</sup>
Stop #5	60.5 mph	147.5 feet	26.69 ft/s <sup>2</sup>
Stop #6	61.0 mph	152.4 feet	26.22 ft/s <sup>2</sup>

**AVERAGE DECELERATION RATE**

**26.70 ft/s<sup>2</sup>**

### Phase III

Evidence of severe fading?

Yes/No

No

Vehicle stopped in straight line?

Yes

Vehicle stopped within correct lane?

Yes

**OVERALL AVERAGE DECEL. RATE:**

**26.86 ft/s<sup>2</sup>**

Projected Stopping Distance from 60.0 mph

144.2

## 2008 Brake Testing Comparison

### STOPPING DISTANCE

